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(54) **A vacuum pumping device**

Vakuumpumpgerät

Appareil de pompe à vide

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(56) References cited:
**EP-A- 0 445 855**
**EP-A- 0 597 365**
**DE-U- 9 417 422**



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## Description

**[0001]** The present invention relates to a vacuum pumping device, particularly of the type comprising a turbomolecular pump.

**[0002]** As it is known, a turbomolecular vacuum pump comprises a plurality of pumping stages housed within a substantially cylindrical casing and provided with an axial inlet port of the sucked gases located at one end, and with a radial or axial-exhaust port of the gases located at the opposite end.

**[0003]** Said pumping stages generally comprise a rotor disk, secured to the rotatable shaft of the pump, that is driven by an electric motor at a speed usually not lower than 25,000 rpm and in case as high as 100,000 rpm.

**[0004]** The rotor disk rotates within stator rings fastened to the pump casing and defining the stator of the pumping stage, with a very small gap therebetween.

**[0005]** In the space between a rotor disk and the associated stator disk it is further defined a pumping channel of the sucked gases.

**[0006]** The pumping channel defined between the rotor and the stator in each pumping stage communicates with both the preceding and the subsequent pumping stages through a suction port and an exhaust port, respectively, provided through the stator in correspondence of the pumping channel of the sucked gases.

**[0007]** A turbomolecular pump of the above type is disclosed, for example, in EP-A-0 445 855 in the name of the present applicant.

**[0008]** The turbomolecular pump described in EP-A-0 445 855 employes both pumping stages provided with rotors formed as flat disks and pumping stages provided with rotors equipped with blades.

**[0009]** This combined arrangement of pumping stages results in a very good performance of the pump in respect of the compression ratio, while allowing to discharge the gases into the outer environment at atmospheric pressure by means of simple pre-vacuum pumps without lubricant, such as diaphragm pumps.

**[0010]** Moreover the construction of a vacuum pump of the turbomolecular type as teached by EP-A- 0 445 855 allows for a considerable reduction of the pump power consumption.

**[0011]** It has been suggested to employ electronic control units or controllers for feeding the electric motor of a vacuum pump in general, and more particularly of the turbomolecular type, such pumps being equipped with an electronic feeding circuit adapted to generate a voltage (or emf) system for feeding the electric motor that rotates the vacuum pump.

**[0012]** Generally such control unit comprises means for converting the available AC mains voltage into the rated voltage level suitable for the operation of the vacuum pump motor, and means for adjusting the feeding voltage level during the pump working cycle on the basis of the residual pressure within the vacuum pump and the operating conditions of the pump motor, from the starting condition to the steady state rotating condition.

**[0013]** Because of the overall size and the cooling requirements, said known unit must be mounted separately from the turbomolecular pump and be equipped with dedicated cooling devices in addition to those already provided for cooling the pump.

**[0014]** The provision of a control unit separated from the vacuum pump, to be independently cooled and electrically connected both to the mains and to the vacuum pump by conductors of suitable length and cross-section, is an inconvenience preventing the construction of vacuum pumping devices that are compact and of small size.

**[0015]** The object of the present invention is to realize a vacuum pumping device, particularly of the turbomolecular type, that is compact and of small size.

**[0016]** This object is accomplished through a vacuum pumping device as claimed in claim 1.

**[0017]** Additional objects of the present invention are accomplished through a vacuum pumping device as claimed in the dependent claims.

**[0018]** The advantages of the invention will become evident from the description of some preferred exemplary but not limiting embodiments of vacuum pumping devices illustrated in the attached drawings in which:

Figure 1 is a partially cross sectioned front view of a turbomolecular vacuum pump;
Figure 2 is a front view of the vacuum pump of Figure 1 showing the motor and the support bearing;
Figure 3 is a perspective front view of the vacuum pumping device according to the invention;
Figure 4 is a rear perspective view of the pumping device of Figure 3;
Figure 5 is a rear partially cross sectioned view of the pumping device illustrated in Figures 2 and 3;
Figure 6 is a perspective top view of the electronic control unit of a pumping device according to the invention;
Figure 7 is a plan view of the casing cover of the electronic control unit of Figure 5;
Figure 8 is a schematic exploded view of a first embodiment of the pumping device in accordance with the present invention;
Figure 9 is a schematic perspective view of the assembled pumping device of Figure 8;
Figure 10 is a schematic perspective view of the pumping device of Figure 9 equipped with an air cooling system;
Figure 11 is a schematic perspective view of the pumping device of Figure 9 equipped with a liquid cooling system;
Figure 12 is a cross sectional view of a second embodiment of the pumping device according to the invention equipped with an air cooling system;
Figure 13 is a cross sectional view of a second embodiment of the pumping device according to the invention equipped with a liquid cooling system;

Figure 14 is a cross sectional view of a third embodiment of the pumping device according to the invention equipped with an air cooling system;
Figure 15 is a cross sectional view of a third embodiment of the pumping device according to the invention equipped with a liquid cooling system.

**[0019]** In the attached Figures the same references have been used to indicate equal or corresponding components.

**[0020]** With reference to Figures 3 to 7 the vacuum pumping device in accordance with the present invention comprises a substantially cylindrical turbomolecular vacuum pump 100 and an electronic control unit 1.

**[0021]** As better shown in Figures 1 and 2, the turbomolecular pump 100 comprises a substantially cylindrical casing 101, having a first portion 102 and a second portion 103, coaxial to the former and with a smaller cross section.

**[0022]** The first portion 102 houses the gas pumping stages, while the second portion 103 houses an electric motor 121 and a bearing 122 for supporting the rotatable shaft 123 of the turbomolecular pump 100.

**[0023]** Rotor disks 113 having flat surfaces and rotor disks 114 equipped with blades are mounted to the rotatable shaft 123 of the pump 100, cooperating with stator rings 115 and 116, respectively, that are secured to the casing 101 of the pump 100 and forming with them gas pumping channels.

**[0024]** The casing 101 is further provided with an axial port 119 located at one end thereof for sucking the gases, and with a radial port 120 for exhausting the gases, located at the opposite end, this latter port being shown in Figure 5.

**[0025]** A plurality of annular grooves 104 defining a series of cooling fins or rings 105 is provided on the outer surface of the first (cross-sectionally) larger portion 102 of the casing 101.

**[0026]** The turbomolecular pump 100 is further provided with an annular protruding ring or flange 110 with peripherally spaced holes 117 for securing the turbomolecular pump 100 to a vessel or chamber (not shown) in which vacuum is to be created.

**[0027]** A cylindrical extension 118 due to the presence within the pump 100 of the bearing and the motor is provided on casing 101, on the opposite side with respect to the flange 110, in correspondence of the base of said second smaller portion 103.

**[0028]** Additionally, as better shown in Figures 3 and 4, on the outer surface of the first larger portion 102 of the casing 101 there are formed three longitudinal grooves 106, spaced by 120° for allowing the passage of as many fastening screws 107 to secure the pump casing 101 to the control unit 1.

**[0029]** Annular grooves 108, defining a series of cooling rings 109 are provided on the outer surface of the second smaller portion 103 of the casing 101.

**[0030]** With reference again to Figures 3 to 7, the control unit 1 comprises a housing 2 having a lower resting surface 3, an upper closure surface or cover 4, and side portions or sides 5 and 6 together defining an inner space 17.

**[0031]** The side 6 comprises a rounded portion 12 and two rectilinear or straight portions 13, substantially parallel to each other.

**[0032]** As shown in Figure 6 in the inner space 17 of the housing 2 there are disposed the electronic components of an electronic circuit for generating a voltage system to feed the electric motor 121 of the vacuum pump 100, and for adjusting the level of the feeding voltage applied to said motor 121.

**[0033]** This circuit is fed through a plurality of leads 50 for the connection to the public power distribution network and comprises two main (printed circuit) boards 56 and 55, the first one being disposed on the bottom of the housing 2 and parallel to the face 3, and the second one being near and parallel to one of the straight portions 13 of the side 6.

**[0034]** In the side 5 there are further provided a removable plug 10 for accessing to a safety fuse (not shown), a sealing ring 11 for the passage of the supply cable 50 of the electronic control unit 1, and connectors 51, 52 and 53 for the exchange of communication and control signals between unit 1 and an external unit (not shown), if required.

**[0035]** As better shown in Figure 7, the upper closure surface 4 is provided with a circular opening 16 allowing the passagge of the second portion 103 of the already discussed cylindrical casing 101 into the space 17.

**[0036]** The second portion 103 is therefore completely contained inside the space provided in the housing 2, while the first portion 102 of the cylindrical casing 101 is located outside the housing 2.

**[0037]** In the rounded portion 12 of the side 6 there are provided slots 9 whereas on the substantially opposite side 5 of the housing 2 there is provided a large opening 7, covered by a net or grid 8. A cooling air flow enters the housing 2 through the slots 9, passes through the interior of the housing 2 and comes out through the opening 7.

**[0038]** The air flow for cooling the inner space of the housing 2 is generated by a cooling fan 54 located internally to the housing 2, in correspondence of the opening 7 in the side 5.

**[0039]** As better shown in Figure 5, between the smaller second portion 103 of the casing 101 and inner walls of the housing 2 there are defined two symmetrical passages 18a and 18b for the cooling air flow entering through the slots 9 and coming out through the opening 7.

**[0040]** In said symmetrical passages there are located the electronic components operating at the highest temperature of said electronic circuit, such as power transistors, microprocessors and transformers.

**[0041]** This way, since the second smaller portion 103 of the casing 101 is located in the same space 17 as the

electronic components of the control unit 1, the air flow generated by a single fan 54 cools at the same time said portion 103 and said "hottest" electronic components

**[0042]** In said space 17 there is further provided a thermistor 57 for sensing the temperature of the electronic components in the control unit 1.

**[0043]** The thermistor 57 is located substantially at the center of the lower circular opening 16 in the cover 4 through which the second portion 103 of the cylindrical casing 101 passes.

**[0044]** The thermistor 57 is further mounted at the top of an upstanding post 59 on the board 56 parallel to the base of the the housing 2 of the control unit 1.

**[0045]** Thus the surface of the thermistor 57 is substantially in thermal contact with the cylindrical extension 118, i.e the extension due to the presence of the bearing and the pump motor inside the pump 100, when the pump 100 is inserted into the housing 2.

**[0046]** In order to improve the thermal contact between the surface of the thermistor 57 and the cylindrical extension 118, a resin layer 58 is interposed between the surface of the thermistor 57 and the cylindrical extension 118.

**[0047]** Since the portion of the pump casing in which the bearing 122 and the motor 121 are located is the portion at the highest temperature, the thermistor 57 can be used for detecting the maximum temperature of the vacuum pumping device and generating interruption control signals when a predetermined threshold of risk is reached.

**[0048]** By integrating the electronic control unit in the turbomolecular pump 100 the length of the leads 60 connecting the feeding electronic unit to the turbomolecular pump 100 is reduced to a minimum, while maintainaing said leads 60 entirely inside the housing 2.

**[0049]** In a preferred embodiment of the vacuum pumping device incorporating a three-phase A.C. asynchronous motor, the electronic circuit for generating the voltage system adapted to feed the electric motor 121 comprises a pair of transistors, one pair for each phase of the voltage system, directly connected to the mains voltage and controlled by signals generated by gate drivers circuits under the control of signals generated by a microprocessor.

**[0050]** In this kind of solution the adjustment of the feeding voltage value to that required by the motor 121 of the vacuum pump 100 can be achieved, for example, by superimposing an ON/OFF pulsating signal generated by the microprocessor, having a constant frequency and a duration capable of being modulated (PWM), to one or more control signals of the gate driver circuits.

**[0051]** This way the signals generated in the gate drivers for driving the transistors, are periodically interrupted in correspondence of the OFF states of the pulsating signal (PWM). Therefore the rms value of the voltage system feeding the electric motor 121 of the vacuum pump 100 is reduced proportionally to the duration of the OFF states of the pulsating signal (PWM).

**[0052]** According to an alternative embodiment of the vacuum pumping device of the invention, the electronic circuit for generating a voltage system for feeding the electric motor 121 can comprises a voltage transformer that converts the voltage value of the public distribution network into a value suitable for actuating the motor of the vacuum pump.

**[0053]** Suitable voltage regulators can be provided in this case to modify the level of the feeding voltage applied to the motor 121 of the vacuum pump 100.

**[0054]** Figures 8 and 9 illustrate a first alternative embodiment of the pumping device according to the invention providing for a substantially prismatic shape of the smaller portion 103' of the casing 101' housing the bearing of the vacuum pump 100' and the electric motor of the vacuum pump.

**[0055]** On the lateral faces 126 of the portion 103' there are provided internally threaded holes 127 for fastening, through screws not shown in the Figures, heat sinks 61 that are in thermal contact relationship with the power components 62 of the electronic circuit that generates the voltage system feeding the electric motor of the vacuum pump 100'.

**[0056]** In the first disclosed embodiment of such circuit, equipped with transistor pairs that are directly connected to the mains voltage, the power electronic components 62 correspond to the power transistors, for example of the MOSFET type, driven by the gate drivers and directly connected to the mains voltage.

**[0057]** The power components 62 are further mounted on a circular board 63 that carries the other electronic components of the feeding circuit.

**[0058]** This circular board 63 and the smaller portion 103' of the casing 101' of the vacuum pump 100' are contained within the inner space 17' of a substantially cylindrical housing 2'.

**[0059]** The housing 2' is further provided with two diametrally opposite series of slots 9' for the air inlet and outlet.

**[0060]** The outer surface of the larger portion 102' of the casing 101' is further equipped with a plurality of annular grooves defining a series of cooling rings 105'.

**[0061]** The device described with reference to Figures 8 and 9 can be equipped with a cooling system using either air or a liquid as a refrigerating fluid.

**[0062]** With reference to Figure 10 it is shown a forced air flow cooling system for the pumping device illustrated in Figures 8 and 9.

**[0063]** The forced air flow is generaterd by a fan 54' located outside the vacuum pumping device and positioned between the walls of a shroud 19, formed by a box-like polyhedral member fastened to the casing 101' of the pump 100'.

**[0064]** The shroud is fastened to the casing 101' and the two opposite bases thereof are open for the air inlet and outlet, so that one of the open bases is partially superimposed both to the larger portion 102' of the casing 101' - where the cooling rings 105' are located - and to

the slots 9' of the housing 2' containing both the smaller portion 103' of the casing 101' of the vacuum pump 100' and the electronic components of the motor feeding circuit.

**[0065]** This way a part of the air flow caused by the fan 54' is directed towards the cooling rings 105' on the larger portion 102' of the vacuum pump 100' and another part is directed into the inner space 17' containing both the smaller portion 103' of the vacuum pump 100' and the electronic components of the electronic circuit generating the feeding voltage system.

**[0066]** This way, with a single fan 54' a flow of cooling air is obtained that cools both the inner space 17' of the vacuum pumping device and the portion 102' outside such space 17'.

**[0067]** Figure 11 illustrates a liquid cooling system of the pumping device shown in Figures 8 and 9.

**[0068]** In this embodiment a refrigerating liquid circulates along an annular channel, substantially coplanar with the rotor disks and formed within the wall of the portion 103' of the vacuum pump 100'. An inlet fitting 124 and an outlet fitting 125 are provided for connecting this annular channel to delivery and return ducts (not shown) of the cooling circuit.

**[0069]** Therefore, by exploiting the liquid cooling circuit in the body of the vacuum pump 100', it is possible to cool also the electronic components in the space inner 17', and more particularly to cool the power components 62 fastened to the heat sinks 61 that are secured to the faces 126 of the smaller portion 103' of the casing 101'.

**[0070]** Figure 12 illustrates a second embodiment of the pumping device according to the invention wherein the electric motor 121" of the vacuum pump 100" comprises a rotor 30 and a stator 31 separated by a cup-shaped casing 32 having an outwardly folded rim for securing the cup-shaped casing 32 to the body of the vacuum pump by means of screws 34.

**[0071]** In addition to the electric motor 121" of the vacuum pump 100", inside the cup-shaped casing 32 there is located a bearing 122 for supporting the rotor 30 of the electric motor 121".

**[0072]** In this embodiment, the casing 101" of the vacuum pump 100" has a first (cross-sectionally) larger portion 102" and a second (cross-sectionally) smaller portion 103", this latter substantially corresponding to the cup-shaped casing 32 disposed between the rotor 30 and the stator 31 of the motor 121" of the vacuum pump 100".

**[0073]** In this embodiment the stator 31 of the electric motor 121" is located outside the space of the pumping device maintained under vacuum and can be subjected to a more effective cooling, e.g. by disposing a heat sink 35 about the stator 31.

**[0074]** A circular board 36 provided with a central bore and mounting the electronic components of the motor feeding circuit of the vacuum pump 100" is secured to the base of the heat sink 35.

**[0075]** Still with reference to Figure 12, the smaller portion 103" of the casing 101" of the vacuum pump 100", is disposed within the space 17" defined inside a housing 2" having a substantially cylindrical shape.

**[0076]** This housing 2" is further equipped with aerating slots 9" for allowing the passage of un air flow generated by a fan 54" disposed outside of the casing 2" and located between the walls of a shroud 19.

**[0077]** The shroud 19 has opposite bases that are open for allowing the air inlet and outlet, and the shroud is preferably secured to the casing 101" so that one of the open bases is partially superimposed to the larger portion 102" of the casing 101" where the cooling rings 105" are located, and is partially superimposed to the slots 9" of the housing 2" containing both the smaller portion 103" of the casing 101" and the electronic components of the feeding circuit.

**[0078]** This way the air flow generated by the fan 54" is partially directed towards the larger portion 102" of the vacuum pump 100", and partially towards the inner space 17" containing both the smaller portion 102" of the vacuum pump 100" and the electronic components of the electronic circuit for generating the voltage system feeding the electric motor.

**[0079]** Advantageously the temperature inside the space 17" can be controlled through a pair of thermistors 64 and 65 that are in thermal contatct with the heat sink 35 and the cup-shaped casing 32, respectively.

**[0080]** Figure 13 illustrates a second embodiment of the pumping device according to the invention as described with reference to Figure 12, in which the vacuum pumping device is cooled through a liquid flow instead of an air flow.

**[0081]** Similarly to the example described with reference to Figure 11, through inlet and outlet fittings 124 and 125 the coolant liquid is admitted into an annular channel 128, substantially coplanar with the rotor disks and provided in the portion 103" of the vacuum pump 100".

**[0082]** This way, by exploiting the liquid cooling circuit in the body of the vacuum pump 100" it is possible to cool also the electronic components in the inner space 17".

**[0083]** Figures 14 and 15 illustrate further embodiments of the pumping devices according to the invention in which the coolant of the vacuum pumping device is air or a liquid, respectively. The devices are those illustrated in Figures 12 and 13, respectively, and are equipped with an electronic circuit for generating a voltage system capable to feed the electric motor of the vacuum pump and comprising a toroidal voltage transformer 40.

**[0084]** The transformer 40 is located inside the casing 2", in the same space 17" containing the remaining electronic components of the feeding circuit.

**[0085]** The transformer 40 is located between the base of the housing 2" and the smaller portion 103" of the casing 101" of the vacuum pump 100".

**[0086]** Moreover, the transformer 40 is fixed to the body of the vacuum pump 100" by means,of a sleeve 41 that is retained by a screw 42 against the base of the cup-shaped casing 32.

**[0087]** From the above description of preferred embodiments of the present invention it is evident that the problem of achieving a vacuum pumping device that is compact and of small size has been advantageously solved and without prejudice of the optimum working condition of the device due to an undesired increase of the temperature of the mechanical and electronic components of the device.

## Claims

1. A vacuum pumping device comprising:

   - a vacuum pump (100; 100'; 100") having a casing (101; 101'; 101") provided with a suction port (119) and an exhaust port (120), in said casing there being defined

     i) a first portion (102; 102'; 102"), housing the gas pumping stages formed by rotor disks (113, 114) secured to a pump rotatable shaft (123), and stator rings (115, 116) secured to said vacuum pump casing and cooperating with said rotor disks (113, 114), and
     ii) a second portion (103; 103'; 103"), housing the electric motor (121; 121") of said vacuum pump and at least one bearing (122) supporting the rotatable shaft (123) of the vacuum pump;

   - an electronic control unit (1) comprising a housing (2; 2'; 2") defining an inner space (17; 17'; 17") containing the electronic components of an electronic circuit feeding the electric motor (121; 121") of said vacuum pump,

   **characterized in that** at least said second portion (103; 103'; 103") of said vacuum pump casing is located within said inner space (17; 17'; 17") containing the electronic components of said electronic feeding circuit.

2. A vacuum pumping device as claimed in claim 1, **characterized in that** it provides means (54; 54'; 54") for generating a flow of cooling air for cooling both said second casing portion (103; 103'; 103") of the vacuum pump located inside said inner space (17; 17'; 17") and said electronic components of said electronic feeding circuit.

3. A vacuum pumping device as claimed in claim 2, **characterized in that** the horizontal cross-section of said casing (2) is substantially semicircular.

4. A vacuum pumping device as claimed in claim 2, **characterized in that** the horizontal cross-section of said casing (2'; 2") is substantially circular.

5. A vacuum pumping device as claimed in claim 3, **characterized in that** said means for generating a flow of cooling air comprises a fan (54) disposed inside said inner space (17), and **in that** said flow of cooling air enters said space (17) through slots (9) formed in a rounded portion (12) of the housing (2), and **in that** said air comes out through an opening (8) in a flat surface-of said housing (2) opposite to said rounded portion (12), said fan (54) being located in correspondence of said opening (8).

6. A vacuum pumping device as claimed in claim 4, **characterized in that** said means for generating a flow of cooling air comprises a fan (54'; 54") disposed outside of said inner space (17'; 17"), and **in that** said flow of cooling air enters into said inner space (17'; 17") through slots (9'; 9") formed in said housing (2'; 2").

7. A vacuum pumping device as claimed in claim 6, **characterized in that** said fan is housed between the walls of a shroud (19), fixed to the casing (101'; 101") of the vacuum pump so that a portion of the air flow generated by said fan (54'; 54") is directed towards said first portion (102'; 102") of the vacuum pump casing, and another portion is directed towards said inner space (17; 17") containing both said second portion (103; 103") of the vacuum pump and the electronic components of the electronic circuit for generating a voltage system feeding the electric motor of said vacuum pump.

8. A vacuum pumping device as claimed in claim 1, **characterized in that** the cross-section of said first portion (102; 102'; 102") of said casing (101; 101'; 101"). is larger than the cross-section of said second portion (103; 103'; 103") of the casing (101; 101'; 101") of said vacuum pump (100; 100'; 100") .

9. A vacuum pumping device as claimed in claim 3, **characterized in that** said casing (2) has an upper closure surface (4) provided with a substantially circular opening (16) for the passage of said second portion (103) of the casing (101) of the vacuum pump (100) that is located in said inner space (17) inside said housing (2).

10. A vacuum pumping device as claimed in claim 2, **characterized in that** said second portion (103) of the casing (101) located inside said inner space (17) defines with the inner walls of said housing (2) two symmetrical passages (18a, 18b) for said flow

of cooling air.

11. A vacuum pumping device as claimed in claim 10, **characterized in that** the electronic components of said electronic circuit in said inner space (17) are substantially distributed around the second portion (103) of the casing (101) of the vacuum pump (100) that is located in said inner space (17).

12. A vacuum pumping device as claimed in claim 10, **characterized in that** those electronic components of said electronic circuit working at the highest temperature and contained in said inner space (17) are substantially positioned in said symmetrical passages (18a,18b) for the flow of cooling air.

13. A vacuum pumping device as claimed in claim 1, **characterized in that** said electronic circuit comprises a thermistor (57) for sensing the temperature in said inner space (17), said thermistor (57) being in thermal contact with the second portion (103) of said pump casing (101) that is located in said inner space (17).

14. A vacuum pumping device as claimed in claim 13, **characterized in that** said thermistor (57) is mounted on a post (59) mounted on a board (56) parallel to the base of said housing (2), on which board some of said electronic components of said feeding circuit are mounted so as to be in contact with the cylindrical extension (118) of the base of said second portion (103) of the vacuum pump casing (101), which extension is due to the presence of said bearing (122)-supporting the rotatable shaft (123) of the vacuum pump-within the second portion (103) of the vacuum pump.

15. A vacuum pumping device as claimed in claim 14, **characterized in that** a layer (58) of resin is interposed between said cylindrical extension (118) and said thermistor (57) to improve the heat transfer therebetween.

16. A vacuum pumping device as claimed in claim 8, **characterized in that** the outer surface of said second smaller portion (103) of the casing (101) of the vacuum pump (100) is provided with a plurality of cooling rings (109) obtained by forming annular grooves (108) on the outer surface of said casing (101).

17. A vacuum pumping device as claimed in claim 1, **characterized in that** the feeding leads (60) connecting said electronic feeding circuit to the motor of the vacuum pump are entirely contained within said housing (2; 2'; 2") when said second portion (103; 103'; 103") is located within said inner space (17; 17'; 17").

18. A vacuum pumping device as claimed in claim 1, **characterized in that** said electronic feeding circuit comprises means for generating a voltage system for feeding the electric motor (121) of said vacuum pump (100).

19. A vacuum pumping device as claimed in claim 1, **characterized in that** said feeding circuit comprises a substantially toroidal voltage transformer (40).

20. A vacuum pumping device as claimed in claim 19, **characterized in that** said transformer (40) is located inside said inner space (17"), between the base of the housing (2") and the smaller portion (103") of the casing (101") of the vacuum pump (100").

21. A vacuum pumping device as claimed in claim 1, **characterized in that** it provides a liquid cooling system.

22. A vacuum pumping device as claimed in any of the preceding claims, **characterized in that** said vacuum pump is a vacuum pump of the turbomolecular type.

**Patentansprüche**

1. Vakuumpumpvorrichtung mit:

   - einer Vakuumpumpe (100; 100'; 100") mit einem Gehäuse (101; 101'; 101"), das mit einem Ansaugkanal (119) und einem Austrittskanal (120) versehen ist, wobei in dem Gehäuse folgendes festgelegt ist

     i) ein erster Teil (102; 102'; 102"), der die Gaspumpstufen unterbringt, die durch Rotorscheiben (113, 114), die an einer drehbaren Pumpenwelle (123) befestigt sind, und Statorringe (115, 116), die an dem Vakuumpumpengehäuse befestigt sind und mit den Rotorscheiben (113, 114) zusammenwirken, gebildet sind, und
     (ii) ein zweiter Teil (103; 103'; 103"), der den Elektromotor (121; 121") der Vakuumpumpe und mindestens ein Lager (122), das die drehbare Welle (123) der Vakuumpumpe abstützt, unterbringt;

   - einer elektronischen Steuereinheit (1) mit einem Gehäuse (2; 2'; 2"), das einen Innenraum (17; 17'; 17") festlegt, der die elektronischen Komponenten einer elektronischen Schaltung enthält, die den Elektromotor (121; 121") der Vakuumpumpe speist,

**dadurch gekennzeichnet, dass** sich zumindest der zweite Teil (103; 103', 103") des Vakuumpumpengehäuses innerhalb des Innenraums (17; 17'; 17") befindet, der die elektronischen Komponenten der elektronischen Speiseschaltung enthält.

2. Vakuumpumpvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** sie ein Mittel (54; 54', 54") zum Erzeugen einer Strömung von Kühlluft zum Kühlen sowohl des zweiten Gehäuseteils (103; 103'; 103") der Vakuumpumpe, der sich innerhalb des Innenraums (17; 17'; 17") befindet, als auch der elektronischen Komponenten der elektronischen Speiseschaltung vorsieht.

3. Vakuumpumpvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der horizontale Querschnitt des Gehäuses (2) im Wesentlichen halbkreisförmig ist.

4. Vakuumpumpvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der horizontale Querschnitt des Gehäuses (2'; 2") im Wesentlichen kreisförmig ist.

5. Vakuumpumpvorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** das Mittel zum Erzeugen einer Strömung von Kühlluft ein Gebläse (54) umfasst, das innerhalb des Innenraums (17) angeordnet ist, und dass die Strömung von Kühlluft in den Raum (17) durch Schlitze (9) gelangt, die in einem abgerundeten Teil (12) des Gehäuses (2) ausgebildet sind, und dass die Luft durch eine Öffnung (8) in einer ebenen Oberfläche des Gehäuses (2) entgegengesetzt zu dem abgerundeten Teil (12) herausgelangt, wobei das Gebläse (54) in Übereinstimmung mit der Öffnung (8) angeordnet ist.

6. Vakuumpumpvorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** das Mittel zum Erzeugen einer Strömung von Kühlluft ein Gebläse (54'; 54") umfasst, das außerhalb des Innenraums (17'; 17") angeordnet ist, und dass die Strömung von Kühlluft in den Innenraum (17'; 17") durch Schlitze (9'; 9") gelangt, die im Gehäuse (2'; 2") ausgebildet sind.

7. Vakuumpumpvorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** das Gebläse zwischen den Wänden einer Ummantelung (19) untergebracht ist, die am Gehäuse (101'; 101") der Vakuumpumpe befestigt ist, so dass ein Teil der durch das Gebläse (54'; 54") erzeugten Luftströmung zum ersten Teil (102'; 102") des Vakuumpumpengehäuses gerichtet wird und ein weiterer Teil zum Innenraum (17; 17") gerichtet wird, der sowohl den zweiten Teil (103; 103") der Vakuumpumpe als auch die elektronischen Komponenten der elektronischen Schaltung zum Erzeugen eines Spannungssystems, das den Elektromotor der Vakuumpumpe speist, enthält.

8. Vakuumpumpvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der Querschnitt des ersten Teils (102; 102'; 102") des Gehäuses (101; 101'; 101") größer ist als der Querschnitt des zweiten Teils (103; 103'; 103") des Gehäuses (101; 101'; 101") der Vakuumpumpe (100; 100'; 100").

9. Vakuumpumpvorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** das Gehäuse (2) eine obere Verschlussfläche (4) aufweist, die mit einer im Wesentlichen kreisförmigen Öffnung (16) für den Durchgang des zweiten Teils (103) des Gehäuses (101) der Vakuumpumpe (100) versehen ist, welcher sich im Innenraum (17) innerhalb des Gehäuses (2) befindet.

10. Vakuumpumpvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der zweite Teil (103) des Gehäuses (101), der sich innerhalb des Innenraums (17) befindet, mit den Innenwänden des Gehäuses (2) zwei symmetrische Durchgänge (18a, 18b) für die Strömung von Kühlluft festlegt.

11. Vakuumpumpvorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die elektronischen Komponenten der elektronischen Schaltung in dem Innenraum (17) im Wesentlichen um den zweiten Teil (103) des Gehäuses (101) der Vakuumpumpe (100) verteilt sind, der sich in dem Innenraum (17) befindet.

12. Vakuumpumpvorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** diejenigen elektronischen Komponenten der elektronischen Schaltung, die auf der höchsten Temperatur arbeiten und im Innenraum (17) enthalten sind, im Wesentlichen in den symmetrischen Durchgängen (18a, 18b) für die Strömung von Kühlluft angeordnet sind.

13. Vakuumpumpvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die elektronische Schaltung einen Thermistor (57) zum Fühlen der Temperatur in dem Innenraum (17) umfasst, wobei der Thermistor (57) mit dem zweiten Teil (103) des Pumpengehäuses (101), der sich im Innenraum (17) befindet, in Wärmekontakt steht.

14. Vakuumpumpvorrichtung nach Anspruch 13, **dadurch gekennzeichnet, dass** der Thermistor (57) an einem Pfosten (59) montiert ist, der an einer Platine (56) parallel zur Basis des Gehäuses (2) montiert ist, an welcher Platine einige der elektronischen Komponenten der Speiseschaltung montiert sind, so dass sie mit der zylindrischen Erweiterung

(118) der Basis des zweiten Teils (103) des Vakuumpumpengehäuses (101) in Kontakt stehen, wobei die Erweiterung infolge der Anwesenheit des Lagers (122)- das die drehbare Welle (123) der Vakuumpumpe abstützt-innerhalb des zweiten Teils (103) der Vakuumpumpe liegt.

15. Vakuumpumpvorrichtung nach Anspruch 14, **dadurch gekennzeichnet, dass** eine Schicht (58) aus Harz zwischen die zylindrische Erweiterung (118) und den Thermistor (57) eingefügt ist, um die Wärmeübertragung zwischen diesen zu verbessern.

16. Vakuumpumpvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die Außenfläche des zweiten, kleineren Teils (103) des Gehäuses (101) der Vakuumpumpe (100) mit einer Vielzahl von Kühlringen (109) versehen ist, die durch Ausbilden von ringförmigen Nuten (108) an der Außenfläche des Gehäuses (101) erhalten werden.

17. Vakuumpumpvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Speiseleitungen (60), die die elektronische Speiseschaltung mit dem Motor der Vakuumpumpe verbinden, vollständig innerhalb des Gehäuses (2; 2'; 2") enthalten sind, wenn sich der zweite Teil (103; 103'; 103") innerhalb des Innenraums (17; 17'; 17") befindet.

18. Vakuumpumpvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die elektronische Speiseschaltung ein Mittel zum Erzeugen eines Spannungssystems zum Speisen des Elektromotors (121) der Vakuumpumpe (100) umfasst.

19. Vakuumpumpvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Speiseschaltung einen im Wesentlichen ringförmigen Spannungstransformator (40) umfasst.

20. Vakuumpumpvorrichtung nach Anspruch 19, **dadurch gekennzeichnet, dass** der Transformator (40) innerhalb des Innenraums (17") zwischen der Basis des Gehäuses (2") und dem kleineren Teil (103") des Gehäuses (101") der Vakuumpumpe (100") angeordnet ist.

21. Vakuumpumpvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** sie ein Flüssigkeitskühlsystem vorsieht.

22. Vakuumpumpvorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Vakuumpumpe eine Vakuumpumpe vom Turbomolekulartyp ist.

**Revendications**

1. Dispositif de pompe à vide comprenant :

   - une pompe à vide (100 ; 100' ; 100") comportant un carter (101 ; 101' ; 101") muni d'un orifice d'aspiration (119) et d'un orifice d'échappement (120), ceux-ci étant définis dans ledit carter

     i) une première partie (102 ; 102' ; 102"), logeant les étages de pompage des gaz formés de disques de rotor (113, 114) fixés à un arbre rotatif de pompe (123) et d'anneaux de stator (115, 116) fixés audit carter de la pompe à vide et coopérant avec lesdits disques de rotor (113, 114), et
     ii) une deuxième partie (103 ; 103' ; 103"), logeant le moteur électrique (121 ; 121") de ladite pompe à vide et au moins un roulement (122) supportant l'arbre rotatif (123) de la pompe à vide ;

   - une unité de commande électronique (1) comprenant un boîtier (2 ; 2' ; 2") définissant un espace interne (17 ; 17' ; 17") contenant les composants électroniques d'un circuit électronique alimentant le moteur électrique (121 ; 121") de ladite pompe à vide,

   **caractérisé en ce que** la deuxième partie (103 ; 103' ; 103") au moins dudit carter de la pompe à vide est située à l'intérieur dudit espace interne (17 ; 17' ; 17") contenant les composants électroniques dudit circuit d'alimentation électronique.

2. Dispositif de pompe à vide selon la revendication 1, **caractérisé en ce qu'**il prévoit un moyen (54 ; 54' ; 54") pour générer un écoulement d'air de refroidissement pour refroidir à la fois ladite deuxième partie de carter (103 ; 103' ; 103") de la pompe à vide située à l'intérieur dudit espace interne (17 ; 17' ; 17") et lesdits composants électroniques dudit circuit d'alimentation électronique.

3. Dispositif de pompe à vide selon la revendication 2, **caractérisé en ce que** la section transversale horizontale dudit carter (2) est sensiblement semi-circulaire.

4. Dispositif de pompe à vide selon la revendication 2, **caractérisé en ce que** la section transversale horizontale dudit carter (2' ; 2") est sensiblement circulaire.

5. Dispositif de pompe à vide selon la revendication 3, **caractérisé en ce que** ledit moyen destiné à générer un écoulement d'air de refroidissement com-

prend un ventilateur (54) installé à l'intérieur dudit espace interne (17), et **en ce que** ledit écoulement d'air de refroidissement entre dans ledit espace (17) à travers des fentes (9) formées dans une partie arrondie (12) du boîtier (2), et **en ce que** ledit air sort à travers une ouverture (8) dans une surface plane dudit boîtier (2) opposée à ladite partie arrondie (12), ledit ventilateur (54) étant intercalé avec ladite ouverture (8).

6. Dispositif de pompe à vide selon la revendication 4, **caractérisé en ce que** ledit moyen destiné à générer un écoulement d'air de refroidissement comprend un ventilateur (54' ; 54") installé à l'extérieur dudit espace interne (17' ; 17") et **en ce que** ledit écoulement d'air de refroidissement entre dans ledit espace interne (17' ; 17") à travers des fentes (9' ; 9") formées dans ledit boîtier (2' ; 2").

7. Dispositif de pompe à vide selon la revendication 6, **caractérisé en ce que** ledit ventilateur est logé entre les parois d'un déflecteur (19) fixé au carter (101' ; 101") de la pompe à vide de façon qu'une partie de l'écoulement d'air généré par ledit ventilateur (54' ; 54") soit dirigée vers ladite première partie (102' ; 102") du carter de pompe à vide et qu'une autre partie soit dirigée vers ledit espace interne (17 ; 17") contenant à la fois ladite deuxième partie (103 ; 103") de la pompe à vide et les composants électroniques du circuit électronique destiné à générer un système de tension alimentant le moteur électrique de ladite pompe à vide.

8. Dispositif de pompe à vide selon la revendication 1, **caractérisé en ce que** la section transversale de ladite première partie (102 ; 102' ; 102") dudit carter (101 ; 101' ; 101") est plus grande que la section transversale de ladite deuxième partie (103 ; 103' ; 103") du carter (101 ; 101' ; 101") de ladite pompe à vide (100 ; 100' ; 100").

9. Dispositif de pompe à vide selon la revendication 3, **caractérisé en ce que** ledit carter (2) présente une surface de fermeture supérieure (4) munie d'une ouverture sensiblement circulaire (16) pour le passage de ladite deuxième partie (103) du carter (101) de la pompe à vide (100) qui est située dans ledit espace interne (17) à l'intérieur dudit boîtier (2).

10. Dispositif de pompe à vide selon la revendication 2, **caractérisé en ce que** ladite deuxième partie (103) du carter (101) située à l'intérieur dudit espace interne (17) définit, avec les parois internes dudit boîtier (2), deux passages symétriques (18a, 18b) pour ledit écoulement de l'air de refroidissement.

11. Dispositif de pompe à vide selon la revendication 10, **caractérisé en ce que** les composants électroniques dudit circuit électronique dans ledit espace interne (17) sont en grande partie répartis autour de la deuxième partie (103) du carter (101) de la pompe à vide (100) qui est située dans ledit espace interne (17).

12. Dispositif de pompage par le vide selon la revendication 10, **caractérisé en ce que** les composants électroniques dudit circuit électronique fonctionnant à la température la plus élevée et contenus dans ledit espace interne (17) sont positionnés sensiblement dans lesdits passages symétriques (18a, 18b) destinés à l'écoulement de l'air de refroidissement.

13. Dispositif de pompe à vide selon la revendication 1, **caractérisé en ce que** ledit circuit électronique comprend une thermistance (57) pour détecter la température dans ledit espace interne (17), ladite thermistance (57) étant en contact thermique avec la deuxième partie (103) dudit carter de la pompe (101) qui est située dans ledit espace interne (17).

14. Dispositif de pompe à vide selon la revendication 13, **caractérisé en ce que** ladite thermistance (57) est montée sur un support (59) monté sur une carte (56) parallèle à la base dudit boîtier (2), certains desdits composants électroniques dudit circuit d'alimentation étant montés sur cette carte pour être en contact avec le prolongement cylindrique (118) de la base de ladite deuxième partie (103) du carter de la pompe à vide (101), ce prolongement étant dû à la présence dudit roulement (122) - supportant l'arbre rotatif (123) de la pompe à vide - à l'intérieur de la deuxième partie (103) de la pompe à vide.

15. Dispositif de pompe à vide selon la revendication 14, **caractérisé en ce qu'**une couche (58) de résine est interposée entre ledit prolongement cylindrique (118) et ladite thermistance (57) pour améliorer le transfert de chaleur entre eux.

16. Dispositif de pompe à vide selon la revendication 8, **caractérisé en ce que** la surface externe de ladite deuxième partie plus petite (103) du carter (101) de la pompe à vide (100) est munie d'une pluralité d'anneaux de refroidissement (109), obtenus en pratiquant des rainures annulaires (108) sur la surface externe dudit carter (101).

17. Dispositif de pompe à vide selon la revendication 1, **caractérisé en ce que** les fils électriques d'alimentation (60) reliant ledit circuit d'alimentation électronique au moteur de la pompe à vide sont entièrement contenus à l'intérieur dudit boîtier (2 ; 2' ; 2") lorsque ladite deuxième partie (103 ; 103' ; 103") est située à l'intérieur dudit espace interne (17 ; 17' ; 17").

18. Dispositif de pompe à vide selon la revendication 1, **caractérisé en ce que** ledit circuit d'alimentation électronique comprend des moyens destinés à générer un système de tension pour alimenter le moteur électrique (121) de ladite pompe à vide (100).

19. Dispositif de pompe à vide selon la revendication 1, **caractérisé en ce que** ledit circuit d'alimentation comprend un transformateur de tension sensiblement torique (40).

20. Dispositif de pompe à vide selon la revendication 19, **caractérisé en ce que** ledit transformateur (40) est situé à l'intérieur dudit espace interne (17"), entre la base du boîtier (2") et la partie la plus petite (103") du carter (101") de la pompe à vide (100").

21. Dispositif de pompe à vide selon la revendication 1, **caractérisé en ce qu'**il prévoit un système de refroidissement par liquide.

22. Dispositif de pompe à vide selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ladite pompe à vide est une pompe à vide du type turbomoléculaire.

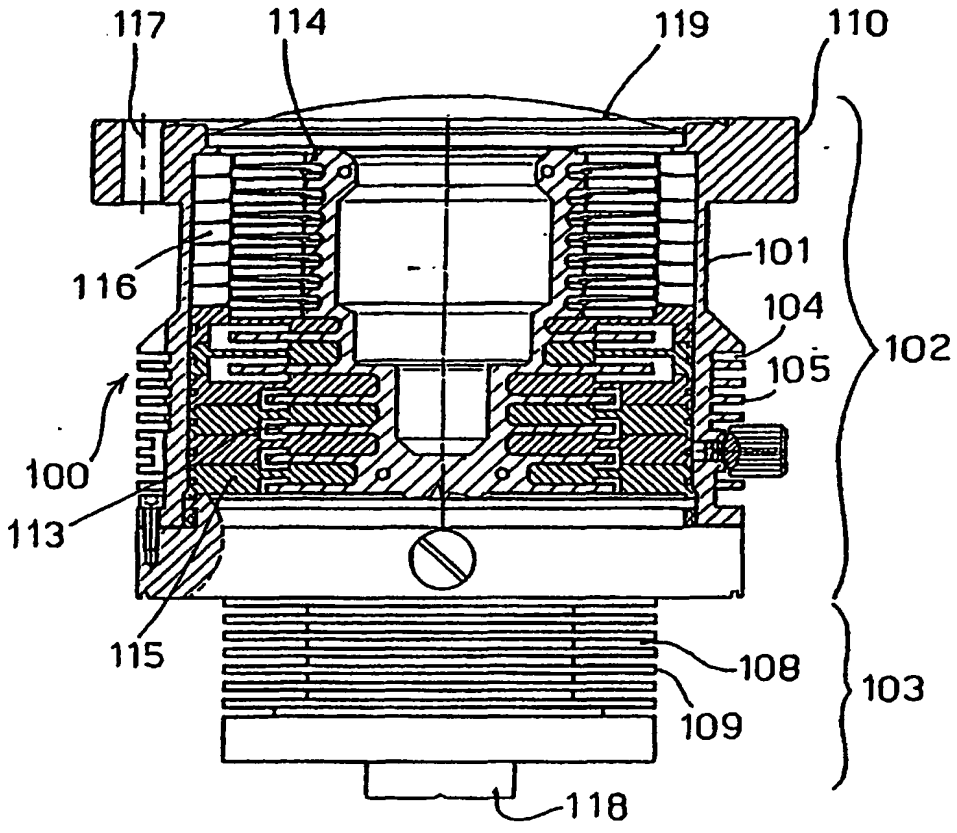


FIG. 1

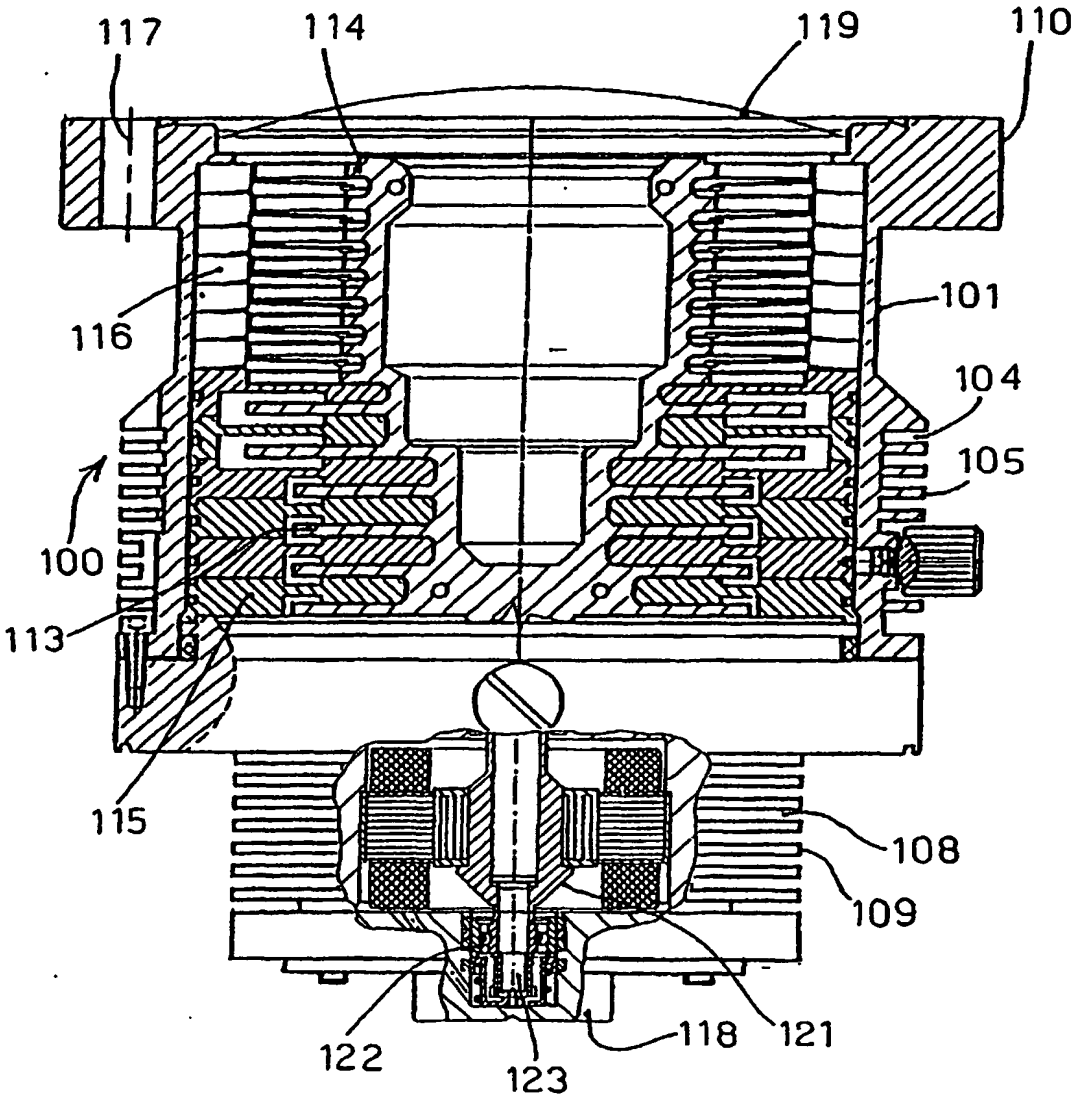
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FIG. 2

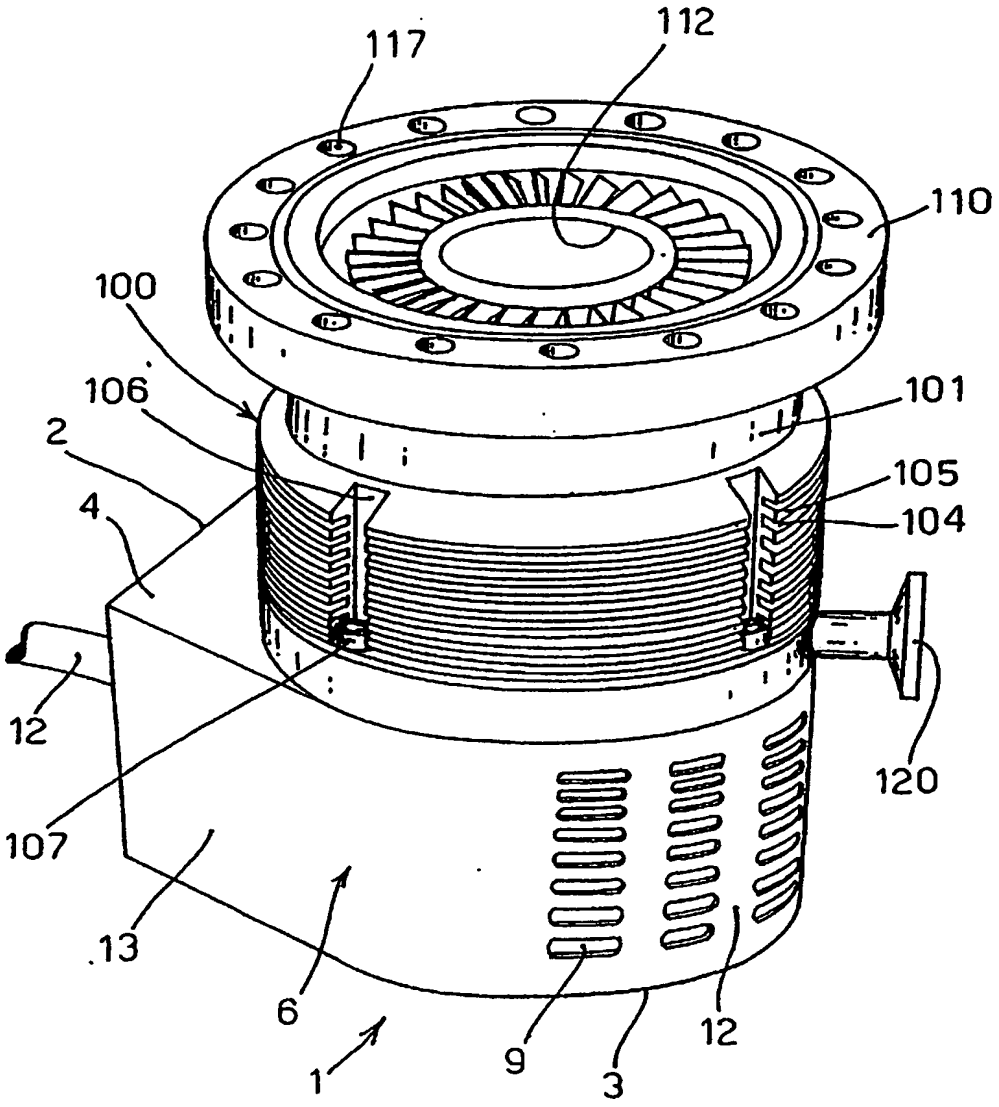


FIG. 3

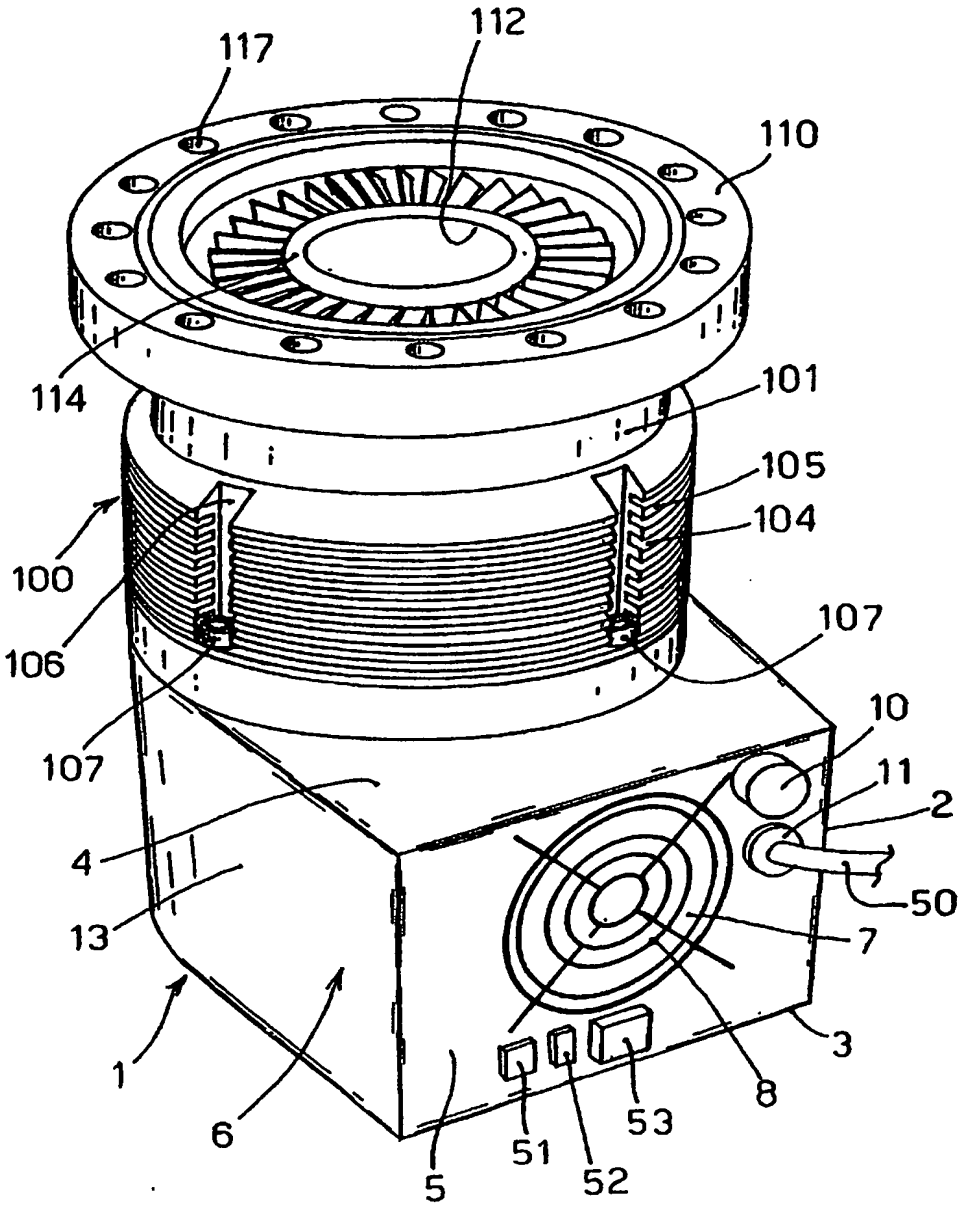
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FIG. 4

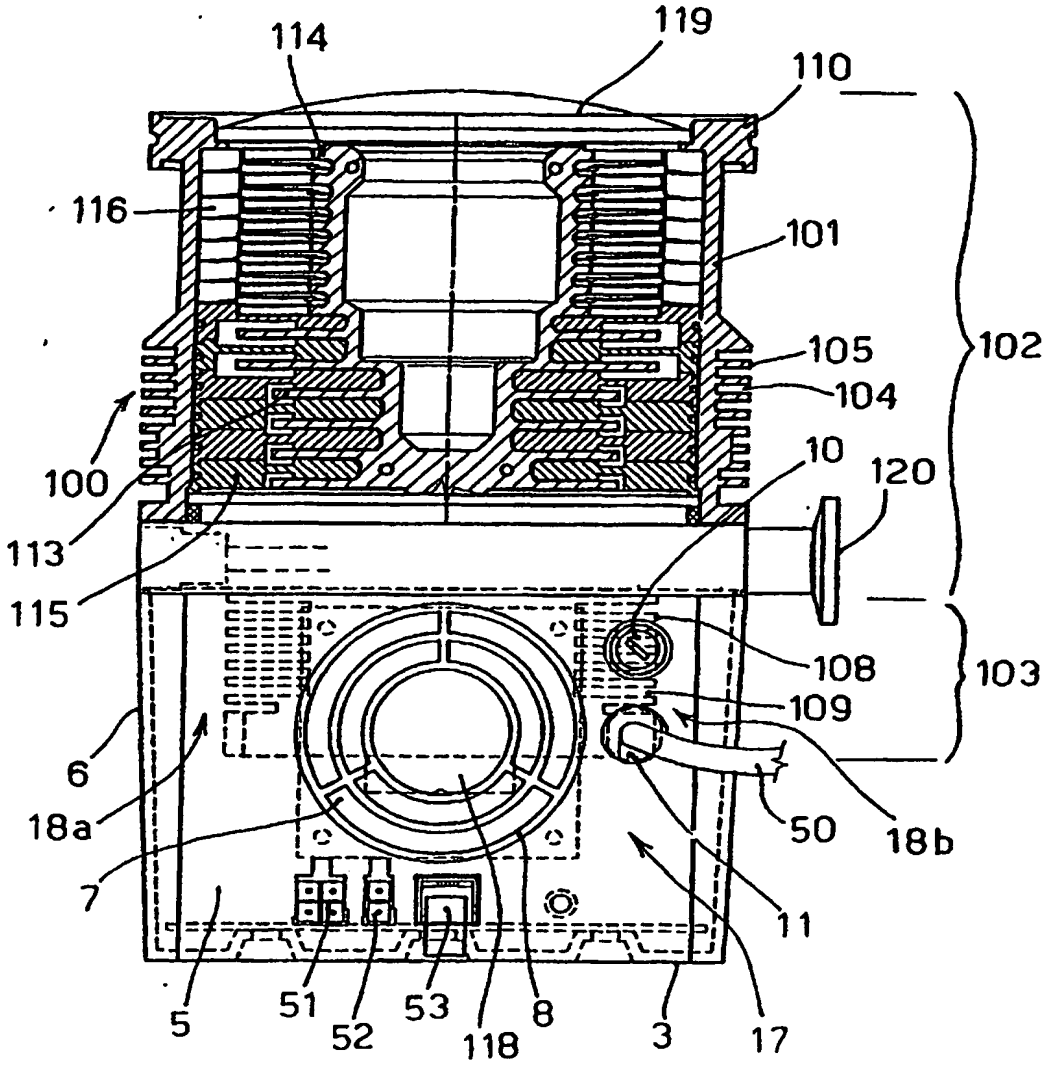
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FIG. 5

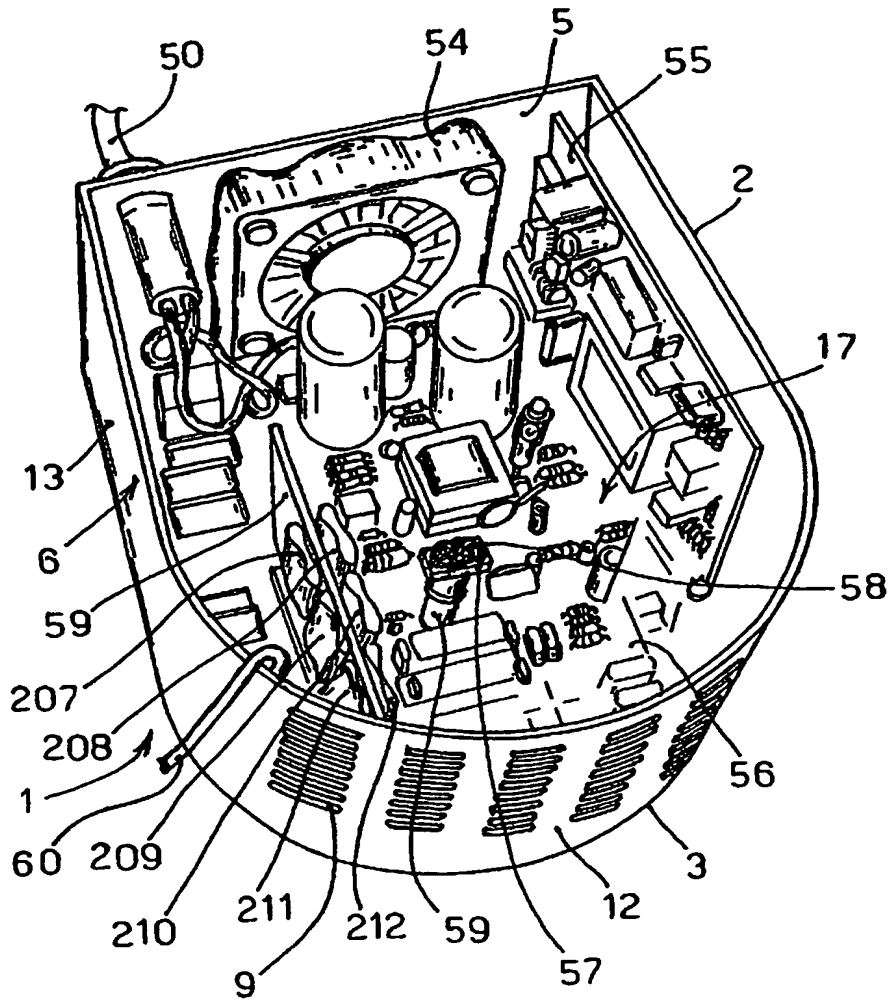



FIG. 6

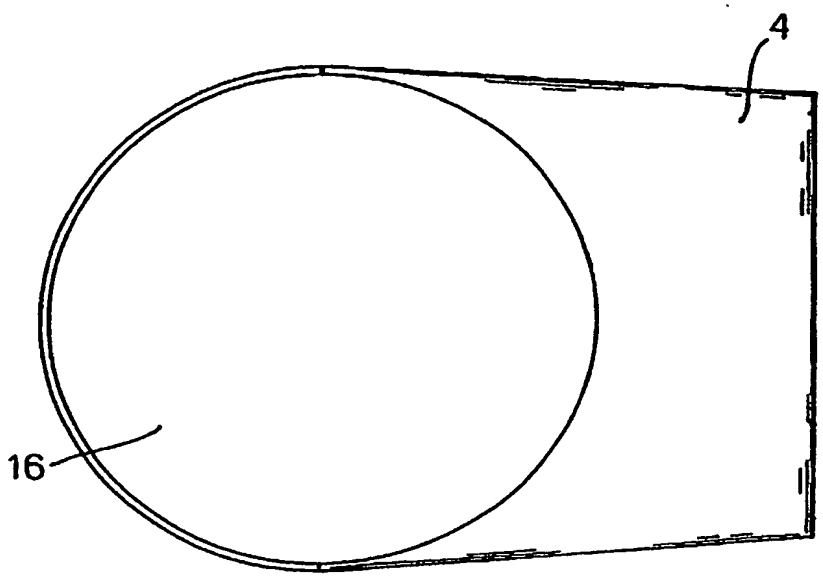
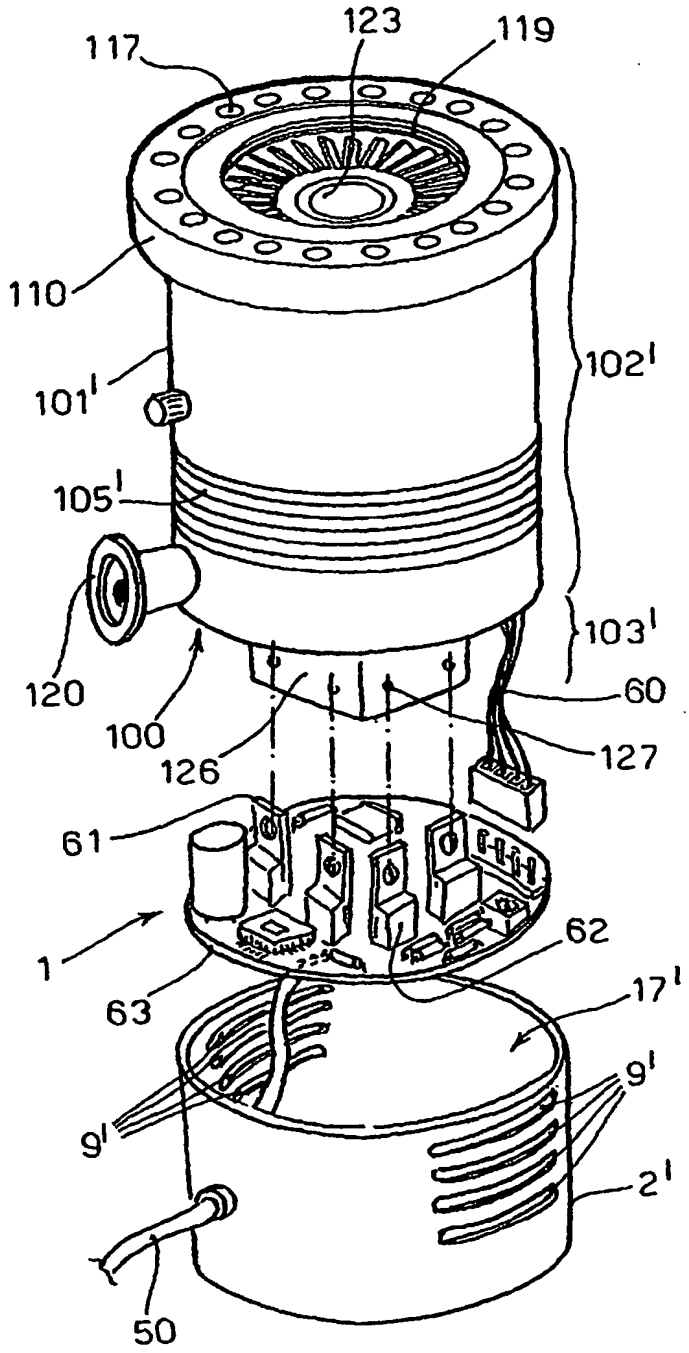



FIG. 7


123
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101'
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FIG. 8

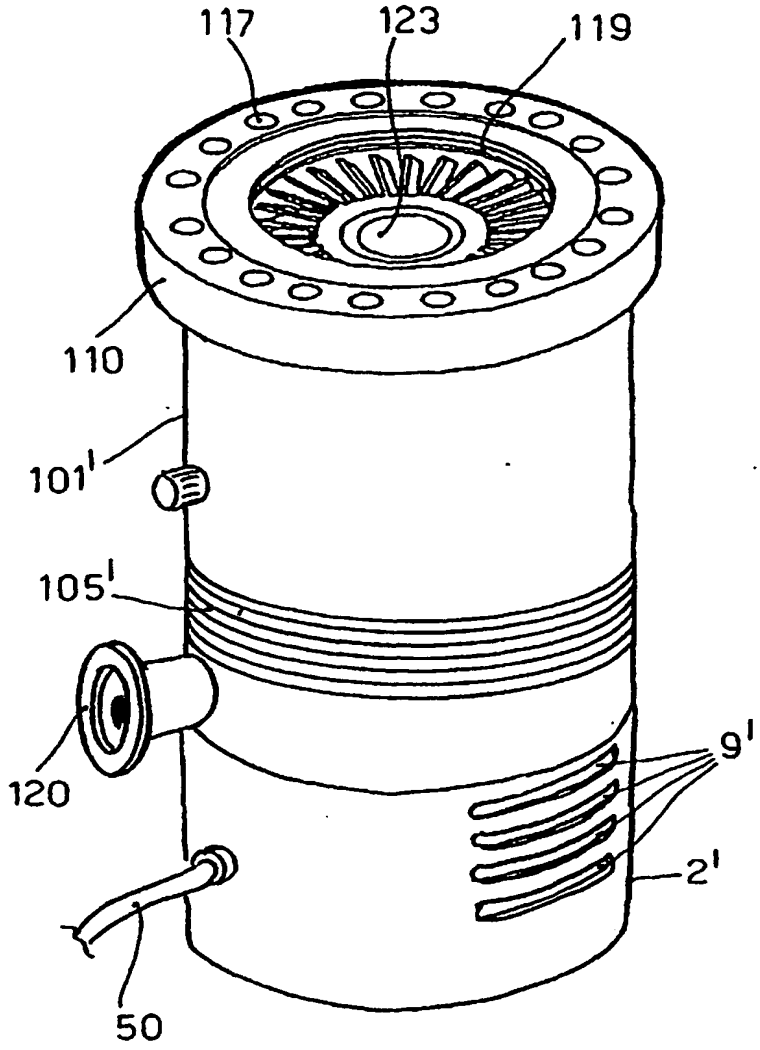


FIG. 9

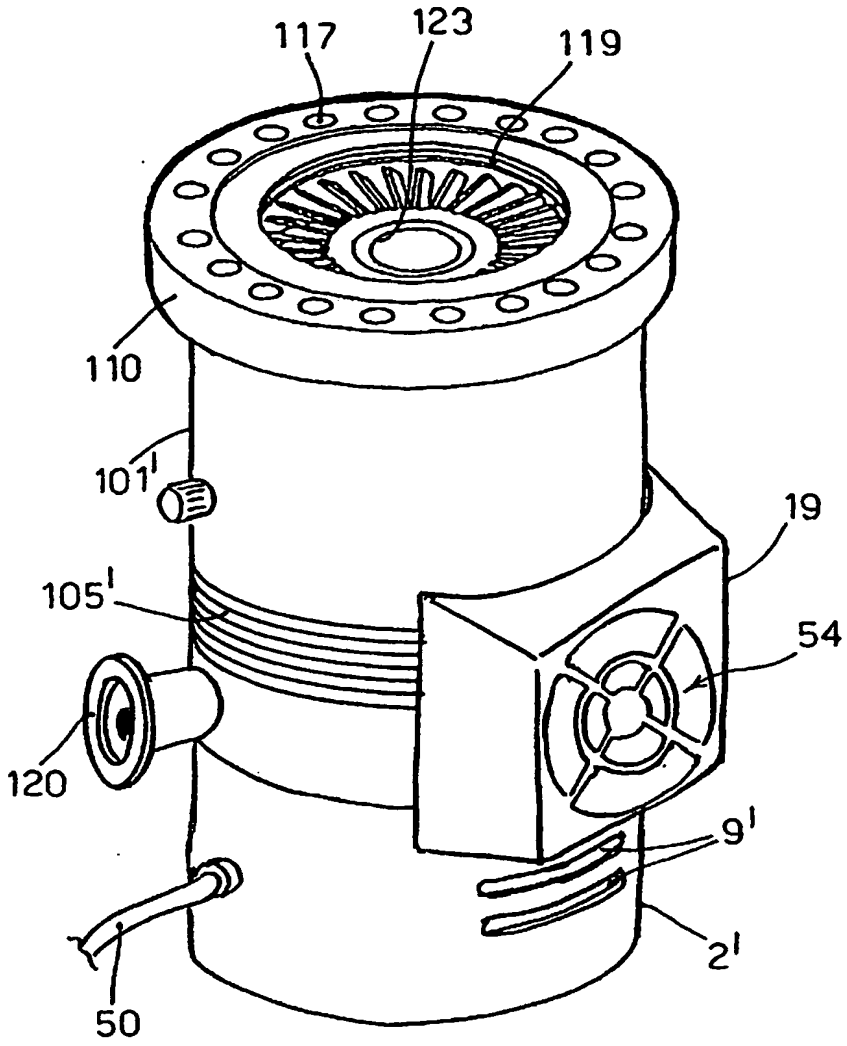


FIG. 10

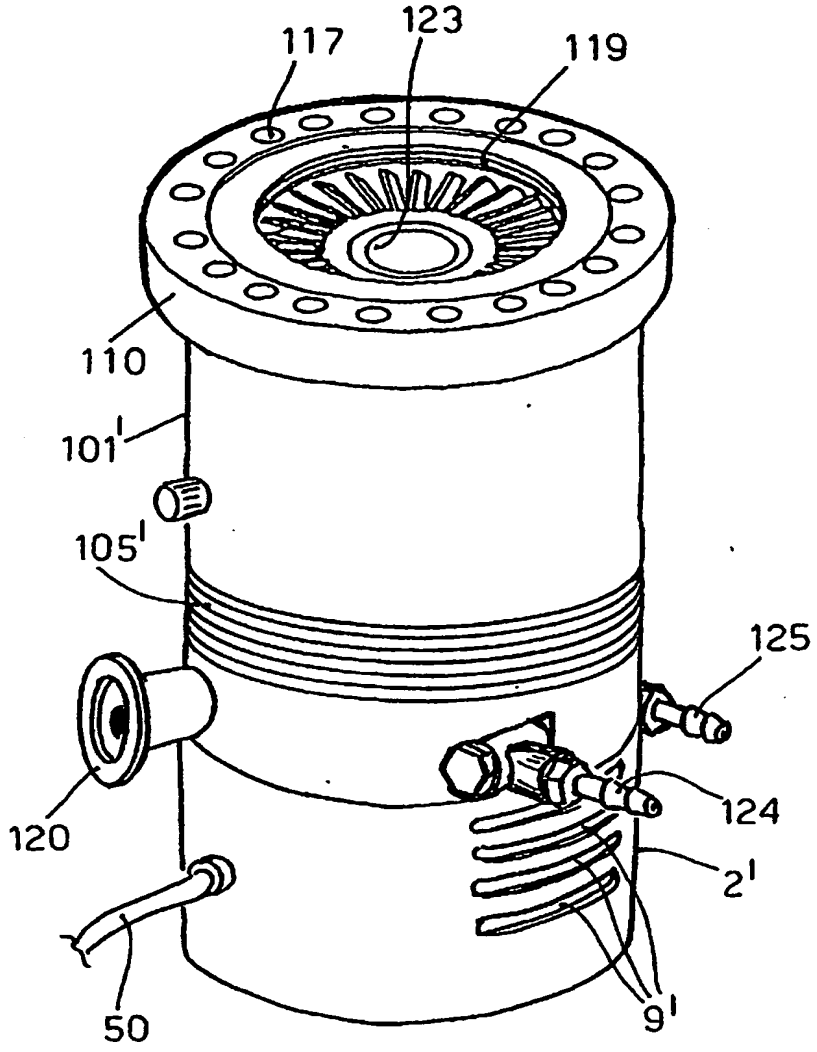


FIG. 11

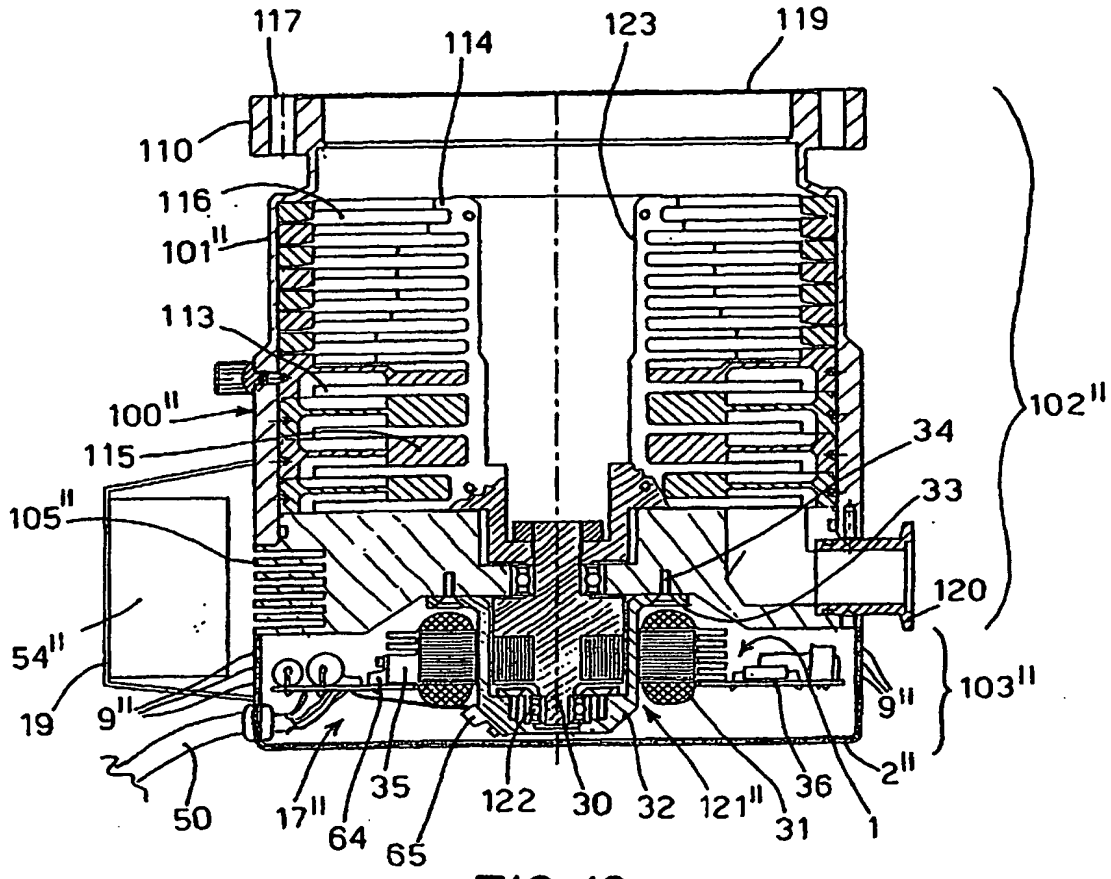
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FIG. 12

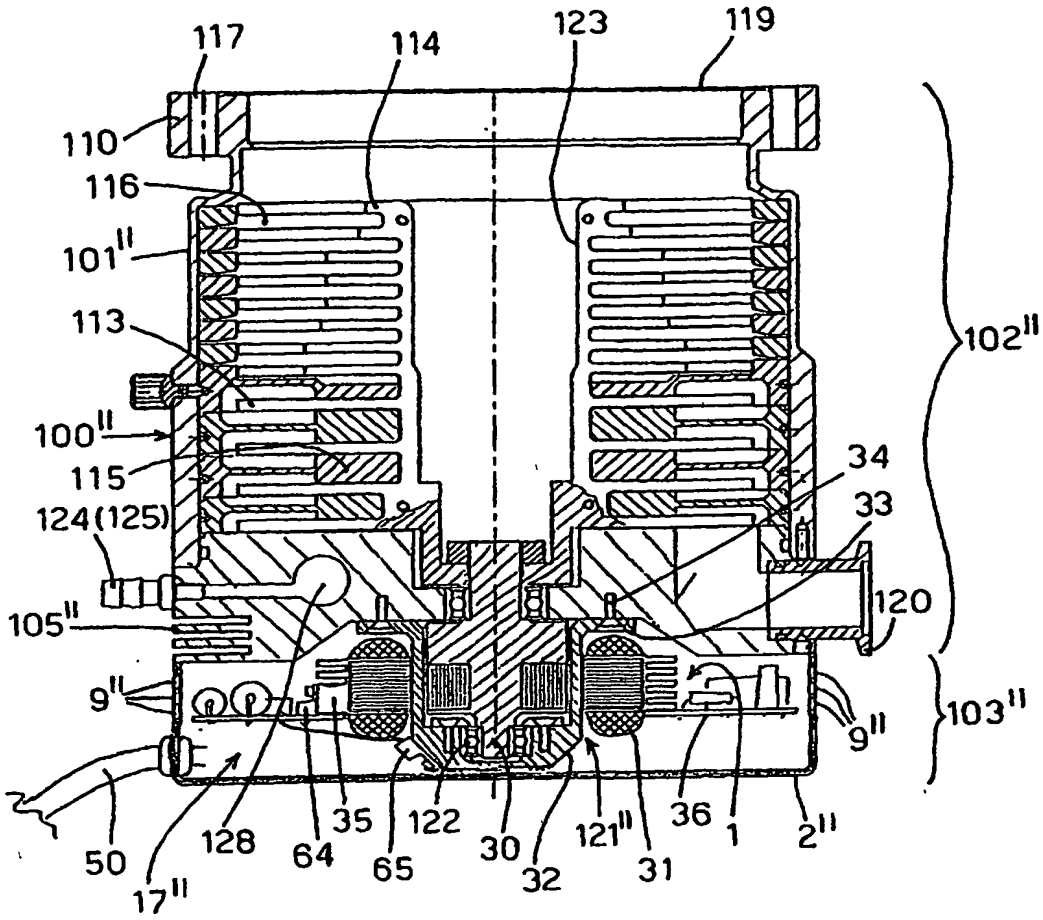
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FIG. 13

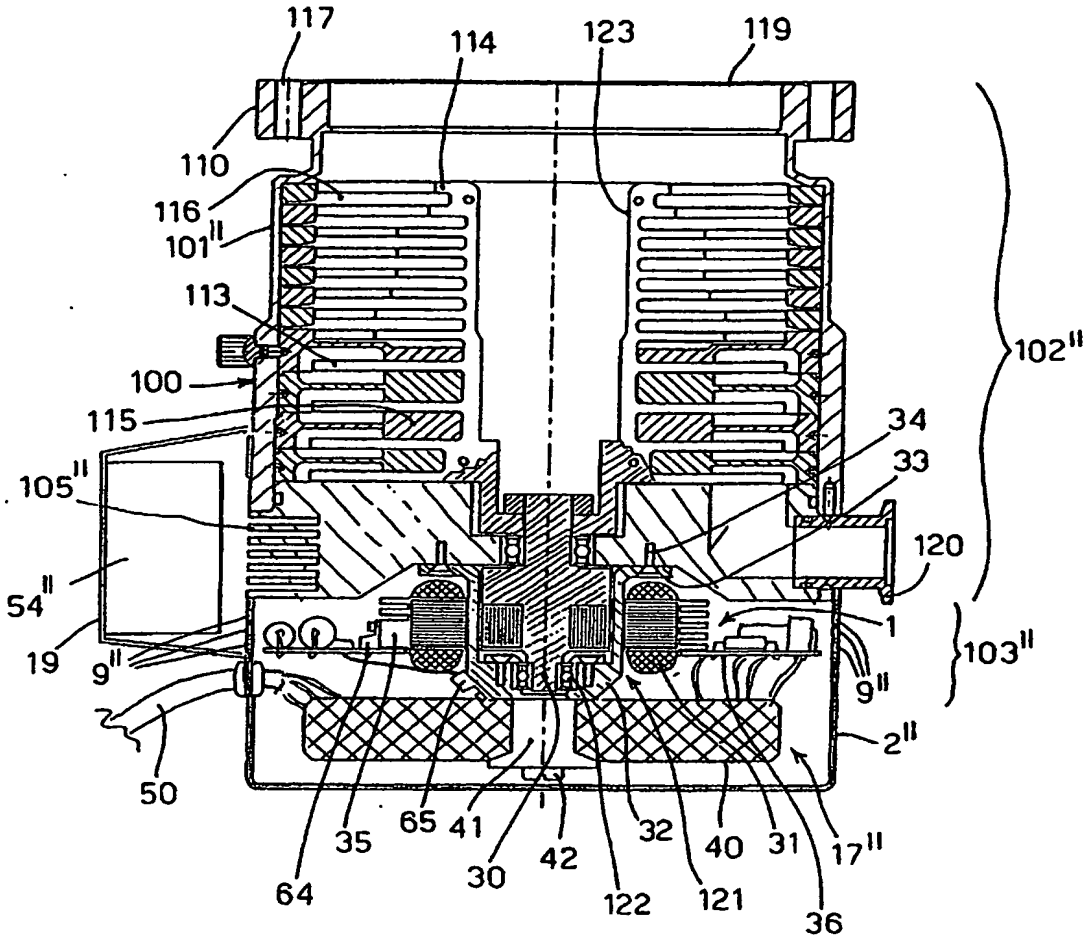
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FIG. 14

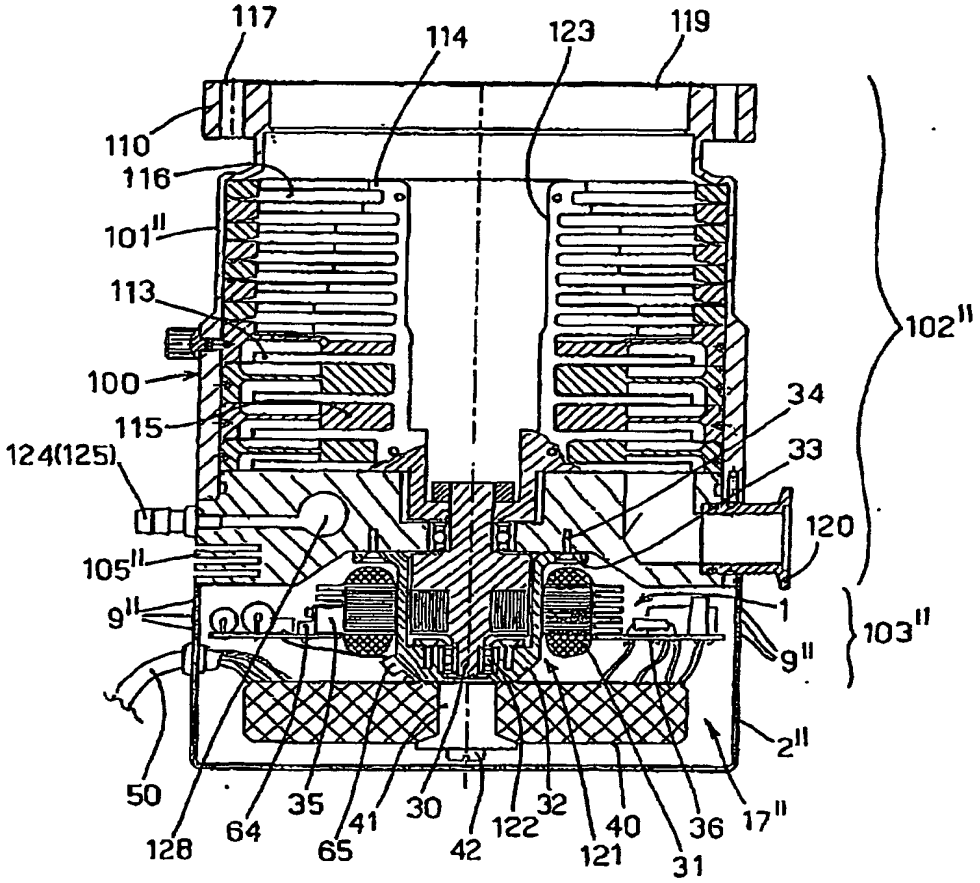
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FIG. 15 motor